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ELECTRICITY.—*The four-terminal conductor and the Thomson bridge.* FRANK WENNER. Communicated by E. B. Rosa. To appear in the Bulletin of the Bureau of Standards.

In the measurement of low resistances the resistances of connectors and contacts are often as large as the resistances with which we may be concerned. It is therefore necessary, if a high precision is desired, to use a method of measurement by which the effects of the resistance of the connecting leads and contacts are eliminated. That is the method must be such that we can limit the resistance measured to that of a part of a conductor which contains no variable connecting resistances. The first requisition then is that the conductor have four terminals suitable for making electrical connections to other conductors or leads. Usually two of the four terminals are designed for making connections to current leads while the other two are designed for making connections to the potential leads.

When a current enters through one of the current terminals and leaves through the other, there is a difference in potential between the potential terminals. The ratio of this potential difference to the current is the resistance of the four-terminal conductor.

When such a conductor is to carry a large current, as is often desired, the current terminals must be large so the current distributions in the conductor depends to some extent upon the way in which the current leads are connected. Where this is the case we are not surprised when we find the resistance of the conductor somewhat indefinite. Where, however, this matter is given due consideration in the design the resistance can be made definite within the limits of measurement, even where the conductor is made of sufficient section to carry 1000 amperes or more.

If the current leads are connected to the potential terminals there is, when a current is flowing, a difference in potential between the current terminals. The ratio of this potential difference to the current is the same as with the regular connections. If the current leads are connected to one of the current terminals and to a corresponding potential terminal, there may be a difference in potential between the other two terminals when a current flows. The ratio of the difference in potential to the current is what we may call the cross resistance.

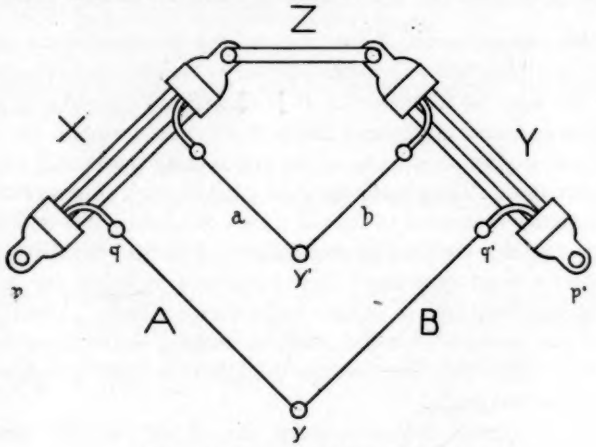


FIG. 1. Thomson Bridge Method

Where the cross resistance is appreciable, errors may be introduced unless the method of measurement is such as to eliminate its effect as well as the effect of the connecting resistances.

Of the different methods available for the comparison of low resistances, we shall consider here only the Thomson bridge method. This method has been in use for about a half century[1] and many of its advantages were pointed out in the original paper. The arrangement of the conductors in the bridge is shown in Fig. 1. Here X and Y designate the low resistance conductors to be compared and A and B the conductors of the main ratio set.

[1] Sir Wm. Thomson, Phil. Mag., **24**: 149. 1862.

Later we shall use X and Y to designate the values of the low resistances and A and B to designate the values of the resistances in the ratio set between p and y, and y and $p.'$ We shall also use X_m and Y_m to designate the inductances of the low resistance conductors. The equations generally given for use with this method have been derived without taking into consideration the cross resistances of the four terminal conductors. The relations given by the equations are therefore not exact as has generally been supposed. Recently Prof. Searle has derived new equations[2] giving the relations between the various resistances including the cross resistances. These equations are necessarily somewhat complicated and in order to be able to use them in calculations, it is necessary to know the values of a large number of resistances. If, however, adjustments are made so that the bridge is in balance using alternately p and $p,'$ and q and q' as branch points and if the balance is not disturbed on removing the connector Z it can be shown that

$$X/Y = A/B \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Low resistance standards are sometimes used in alternating current measurements. In such cases it is generally necessary to know both the resistance and inductance or to know that the inductance is so small that at the frequency used, the phase angle may be considered zero. The Thomson bridge method may be used for measuring both the resistance and inductance.

A general equation, giving the relations between the resistances inductances and frequency of the alternating current necessary for a balance, would be very complicated. If however, adjustments are made so that, under the conditions given above, the bridge is balanced both when using direct current and when using alternating current the relations become much simpler and as a particular case it can be shown that

$$X_m/Y_m = X/Y = A/B \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Here it is assumed that the inductances of A and B are so small in comparison with their resistances that their time constants may be considered zero.

[2] Electrician, 67: 57. 1911.

EVOLUTION.—*Evolution in discontinuous systems.* III.[1] ALFRED J. LOTKA. Communicated by J. A. Fleming.

In our considerations so far we have supposed r_1, the fractional rate of increase of any group A_1, to be a given function of the general conditions of the system, and in particular of the masses M_h and M_1.

Let us now look a little more closely at this function r, and examine it in its relation to the physical properties of the living organism.

In the first place we note that

$$r = \frac{1}{M}\frac{dM}{dt} = \frac{1}{M}(B - Z) \quad \ldots\ldots\ldots\ldots (31)$$

If m is the average mass of one individual, we have

$$M = Nm \quad \ldots\ldots\ldots\ldots\ldots\ldots (32)$$

For our present purpose it will be sufficiently near the truth to assume m to be constant. In that case

$$r = \frac{1}{M}\frac{dM}{dt} = \frac{1}{N}\frac{dN}{dt} = \frac{1}{N}(G - S) = (g - s) \quad \ldots\ldots\ldots (33)$$

where

G = total number of births per unit of time, and

S = total number of deaths per unit of time.

Our problem, then, is to investigate G and S, or g and s as functions of the physical properties of the organism.

It may appear at first sight the most logical procedure to discuss first of all B or G. On looking into the matter, however, we find that B can always be referred back to Z, and that the latter appears really more directly related to the physical properties of the system, so that its discussion naturally takes first place.

The statement has just been made, that B can always be referred back to Z. This is evidently true, for whatever material is gained by one group, must be lost by one or more other groups, or to express this in the form of an equation,

[1] See this Journal, 2: pp. 2 and 49, 1912.

$$B_1 = \sum_{v=1}^{v=\omega} \lambda_{1,v} Z_v \ldots\ldots\ldots\ldots\ldots\ldots (34)$$

where the coefficients $\lambda_{1,v}$ have an obvious import.

But in many cases there is also a simple relation between g and s. Thus for a stationary condition we have

$$g = s \ldots\ldots\ldots\ldots\ldots\ldots\ldots (35)$$

while, under constant conditions, birth and deathrate tend to approach the relation

$$\frac{1}{g} = \int_0^\infty e^{-(g-s)a} p(a) da \ldots\ldots\ldots\ldots\ldots (36)^2$$

where $p(a)$ is the probability, at birth, that an individual picked out at random from among newly born shall reach age a.

We obtain still another relation between g and s if we suppose that matters have so adjusted themselves, that the birthrate is the one that gives the maximum rate of increase for the population, a condition which is presumably approached in nature. In such a case we must have

$$\frac{dr}{dg} = \frac{d(g-s)}{dg} = 0 \ldots\ldots\ldots\ldots\ldots\ldots (37)$$

or

$$\frac{ds}{dg} = 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (38)$$

Our immediate task, then, is to discuss the influences which determine the deathrate of a given group. Obviously such deathrate will depend (1) On external conditions; (2) On the the properties of the group.

As regards the first of these two factors, we note that in general the external influences to which the individual is exposed vary from point to point in space and from instant to instant at a given point. For the purposes of our present discussion we shall

[2] Lotka, Am. Jl. Sci., 24: 201. 1907. Science, 26: 22. 1907. Sharpe and Lotka, Phil. Mag., p. 437, April, 1911.

suppose that the mode of variation is given, so that we may restrict our discussion to the second factor, the dependence of the death rate, under given external conditions, on the properties of the group.

We noted at the outset, that the distinguishing characteristic of the kind of changes with which we are here concerned, is their discontinuity. Let us consider a little more in detail how this discontinuity enters into play in the case of an aggregate of living organisms. If we single out some one particular individual, and follow up its history, we shall see it exposed, in its travel through time and space, to fluctuating internal and external conditions. This will in general lead to changes in the distribution of energy both within the individual and between it and the environment. With regard to such redistribution of energy the following observation is to be made:

In general an infinitesimal change in the distribution of energy in a material system brings with it an infinitesimal change in the condition of the system. If, however, such change in distribution continues in a given direction, sooner or later a point will in general be reached, beyond which any further change, even if infinitesimal, will now cause a finite change in the condition of the system. Thus a discontinuous change takes place. Analytically we might express these facts somewhat as follows: Let P be some one of the parameters which serve to define the state of the system under consideration. Let the distribution of energy in the system suffer a change by the passage, in stated manner, of a quantity dQ_1 of some form of energy E_1 from one portion of the system into another, or from the surroundings into the system. Then in general $\frac{dP}{dQ_1}$ is a finite and continuous function of Q_1. After a certain quantity Q_c has been transferred, however, and the parameter P has reached a corresponding critical value P_c, any further increment dQ_1, however small, now causes a finite change in P—in other words the function $\frac{dP}{dQ_1}$ has a discontinuity at this point. We may speak of P_c as the "critical" or "limiting strain" of the system for the par-

ticular form of energy and mode of redistribution of the same. Each system has a definite set of such limiting strains, which represent characteristic properties, and which we may speak of collectively as the "passive resistance" of the system to impressed modifications.

If we turn our thoughts back now to the consideration of the individual organism whose history we were following up, we observe that in general, among the fluctuating influences to which it is subjected, there will sooner or later arise conditions in which a "limiting strain" is exceeded—the individual suffers a discontinuous change, which may be of such character as to kill it, *i. e.*, eliminate it from the aggregate.

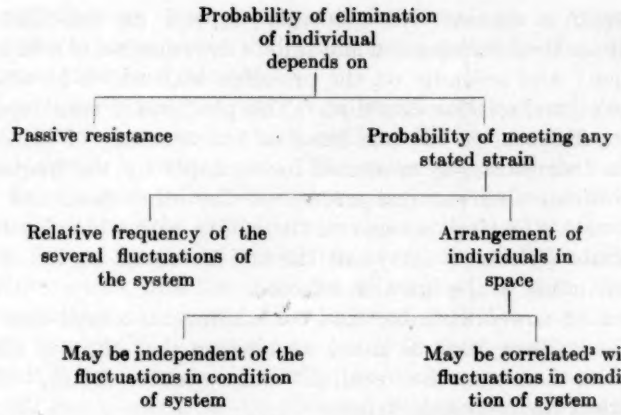
Under the conditions of the problem as it presents itself to us in nature we can not in general foretell when a particular individual will meet with the fatal variation. We may know, however, in a statistical way, what fraction $p(a)$ out of some large number of individuals, picked out at random and counted at the moment of their birth, will reach age a, or, what amounts to the same thing, what proportion $\mu(a)$ of individuals at age a are eliminated per unit of time. Our problem is to analyse $\mu(a)$ in its relation to the properties of the organism.

An analysis of the factors which determine $\mu(a)$ leads us first of all to a division of these into two classes. For the probability that a given individual shall be eliminated from its continuum, in a small interval of time dt say, depends on two kinds of conditions: Firstly on the "passive resistance" of the individual, as defined above, and as measured by the set of values of the several P_e; secondly on the probability that the individual shall be exposed to any stated strain during the interval dt. This latter probability itself in turn depends on two factors; firstly on the relative frequency of the several fluctuations in the conditions of the system; and secondly on the probability that a given fluctuation occur in such relation to time and space that the individual under consideration is affected thereby. Finally, this last probability depends on the distribution and disposition (arrangement) of the individuals in space. And in this respect there are two cases to be distinguished. On the one hand the

arrangement of the individuals in space may be independent of the distribution of the "fluctuations" in the system—at least so far as the critical limits are not exceeded—; thus, for example, according to the simpler form of the kinetic theory, which regards the molecules as elastic spheres, the probability of finding a molecule at the point x, y, z is independent of the coördinates and velocities of the other molecules, provided only that x, y, z does not fall within the radius of another molecule. If we suppose that chemical action takes place at the time of a collision between two molecules, then we see that in this case, the occurrence at a given point, of a fluctuation which would cause a molecule placed at that point to be eliminated from the aggregate (namely the presence there of another molecule with certain velocity components), has no influence upon the probability that some molecule or other shall be moving upon the point in question at the moment considered.

But in an important class of cases the arrangement of the individuals in space is not independent of the distribution of the fluctuations in space; on the contrary, there is a more or less close "correlation" between the occurrence of certain fluctuations in the general conditions of the system and the presence of an individual at the corresponding point of time and space. In fact, it is hardly too much to say, that the dominant tendency in the evolution of the highest types of living organisms, and of modern man in particular, is to make this correlation as close as possible.

Before we proceed to consider more in detail the manner and means by which this correlation is secured, it will be well to summarise in tabular form the essential points of our analysis. Expressing successive dependencies on the pattern of genealogical tables, we obtain the following picture:


Probability of elimination of individual depends on
Passive resistance
Probability of meeting any stated strain
Relative frequency of the several fluctuations of the system
Arrangement of individuals in space
May be independent of the fluctuations in condition of system
May be correlated[3] with fluctuations in condition of system

Let us now briefly consider how this correlation between the conditions of the system from point to point and the disposition of the individuals in space is established. It will be useful to illustrate by means of a simile the phenomena here involved.

The individual in its struggle for existence may be likened to a fencer A, whose opponent B represents the external world. We will think of B as being immortal, a condition which might be realized for example by immediately replacing him by a substitute as soon as he received a serious injury. Then, however excellent A's fencing might be, short of absolute perfection, sooner or later he must succumb to the attack of his assailant. Now we may roughly represent the course of the combat as follows: B makes the attack. Let $x'\ y'\ z'$ be the coördinates of the point of his sword. For the sake of simplicity we will suppose that these coördinates define B's position at every moment sufficiently for our purposes. A's task is to parry each of B's thrusts. In other words, if $x\ y\ z$ are the coördinates of A's swordpoint, A's problem is to make $x\ y\ z$ such functions of $x'\ y'\ z'$, that the latter coördinates at no instant fall within the geometrical boundaries of his vital organs.

[3] Such correlation is probably possible only in a system having a fund of free energy. The phenomenon is closely related to "relay action," in which "action and reaction" are *not* equal.

Now A's success will evidently depend on two factors: Firstly on his determination and skill in the selection of a suitable function; and secondly on the precision with which he attains the functional relation aimed at. This precision in turn depends on two factors: on the one hand on the accuracy of his sense organs (receptors), as measured for example by the frequency curve of his observational errors; on the other hand the precision of A's fencing depends on the agility with which his body and limbs (effectors) carry out the actions aimed at, i.e., those corresponding to the function selected.

Leaving now our simile,[4] and considering the actual case of a living organism, such as man, we observe that thruout all his activities there runs the so-called "sensory-motor circuit," which comprises the following steps:

1. The external world is "represented" (in the mathematical sense)[5] in the individual. This is effected partly by the sense organs (receptors), and partly also with the assistance of the thinking organ, which, by logical argument, further develops the representation formed directly by the sense perceptions.

2. The representation of the external world so obtained calls out another representation of a "modified external world." (The modification may involve both the external world and the individual.) If this modified "representation" be a subject of consciousness in the individual, we recognise it as a "desire," "purpose," or "intention." If several alternatives of this kind are presented, in general one of these is selected. If this choice is made by a conscious process, it is determined by a faculty which may be termed the "judgment of value" of the individual.

3. The third and terminal step in the circuit is an "action" of the individual, whereby the external world is so modified as to correspond with greater or less accuracy to the "modified representation" of the external world, which we noted under (2). At this step also, as in (1), thought-processes may assist in

[4] This simile is of course incomplete in so far as we have supposed A to remain purely on the defensive, whereas the typical living organism must necessarily make active attack. This does not, however, materially affect the argument, since the same principles apply to its actions in either attitude.

[5] The German word "abgebildet" is particularly expressive.

the carrying out of the "purpose" in view, i. e., in impressing upon the external world the form corresponding to the modified representation just referred to.

Now the efficiency of the "receptor-effector system" depends on the perfection with which each of the steps of the sense-motor circuit is carried out. The investigation of the function r in its relation to the physical properties of an organism such as man for example therefore resolves itself into the discussion of the several sources of "error" in the working of the receptor-effector system, and the influence of such errors upon the rate of increase of the group. No attempt shall be made here to attack this problem, or even to put it in mathematical setting, tho this latter offers no difficulty, and might prove instructive. We will rest content on this occasion with a tabular synopsis of the principal sources thru which errors enter into the functioning of the receptor-effector system. Such a table appears as follows:

SYNOPSIS OF THE STEPS IN THE SENSORY-MOTOR CIRCUIT, WITH THE CORRESPONDING SOURCES OF ERROR.

	1. *Representation of the external world in the individual*	
A.	Sense perceptions	Observational error
B.	Reasoning (as a step in the further development of the image formed by the senses)	Logical error
	2. *Determination of the "Modified Representation"*	
A.	Unconscious (Reflex)	Deviation from the "best adapted" modified representation[6]
B.	Conscious: "Valuation" of several possible "modified representations" and selection of one of them	Error of the "judgment of value"[7]
	3. *Action*	
A.	Actuation of limbs, etc.	Operational error
B.	Reasoning (as a step in the realisation of the "modified representation")	Logical error

[6] It is presumably by such a "false reflex" that a moth is drawn into the destroying flame.

[7] Flagrant errors of this kind are seen for example in the case of the drunkard, the gambler and so forth.

While this table must be regarded as more or less provisional, it represents perhaps a first step in that analysis of the phenomena involved, which must necessarily precede any quantitative treatment of the problem before us, namely the investigation of the rate of increase of a given type of organisms, as a function of their physical properties. So much, perhaps, has been made clear, that the subject is closely related, on the one hand to the theory of observational error, and on the other to the theory of value. This last point, on closer inspection, seems to offer some specially alluring prospects for further study. Mathematically the problem at this point takes the form typical of the calculus of variations: In an evoluting system of the kind considered, certain functions must tend to assume such form as to make the probabilities of a fatal encounter a minimum.

If on the other hand we contemplate the subject of our "judgment of value" in its philosophical relation to human life again we are met by a number of interesting suggestions.

But at this point my subject merges into the realm of sentiment, which one is reluctant to enter.

PHARMACOLOGY.—*Physiological studies in anaphylaxis. VI. The reaction of the opossum to horse serum.* W. H. SCHULTZ and H. E. JORDAN, Hygienic Laboratory. Communicated by J. W. Kerr. To appear in a Bulletin of the Hygienic Laboratory.

The intact non-sensitized opossum reacts only slightly to large intraperitoneal doses of horse serum, this action being evidenced chiefly by signs of abdominal cramps. The anesthetized non-sensitized animal records a temporary fall, and sometimes a slight rise of blood pressure and a change in the rate and force of respiration when injected intravenously with 0.0025 cc. of horse serum per gram body weight.

The intact opossum sensitized toward horse serum reacts very energetically to intraperitoneal and intravenous injections of serum, as is evidenced by the passage of urine and feces, the frequent yawning, the slowing and deepening of the respiration, vomiting, muscle weakness, and signs of abdominal cramps. The

animal may or may not recover, depending upon the gravity of the symptoms elicited by the toxic dose of serum. For example there was observed in one sensitized opossum, under ether anesthesia, a sharp fall of blood pressure from 122 to that of 20 mm. of mercury, at which latter level the pressure remained for three or more minutes. The respiration changed from a rate of 44 per minute, before the fall of blood pressure, to one of 54 during the fall, with a diminished respiratory output. As soon as the blood pressure reached its lowest level the respiration was greatly slowed and increased in force. The oscillation of the intrapleural pressure was also greatly increased and accompanied by a gradually increased inspriatory period until finally respiration ceased in the semi-inspiratory stage; whereupon the animal, after some minutes, gave a series of gasps and recovered, whereas in another animal the respiratory gasps were absent and the animal failed to recover.

The blood vessels of the opossum's lung react much as do those of the guinea-pig while the bronchi react more like those of the cat-lung.

One of the most interesting phenomena observed in one highly sensitized animal, but which may not prove to be characteristic of the anaphylactic opossum, is the reaction of the blood. In this animal the arterial blood became milk-red in appearance and upon bleeding the animal a milk-like layer floated to the surface and was pipetted off. If the horse serum was present in large quantities in a large blood vessel masses of the white material seemed present and in time became tough, but where the serum was more thoroughly mixed with large quantities of blood the particles as seen thru the microscope were extremely small. This very finely divided emulsion when dried as a film upon a cover slip revealed a rich supply of fat droplets after staining with Sudan III, or with osmic acid. There was also other material, the nature of which has not yet been determined, but which took Hasting's and also Wright's stain and appeared like cellular and protein débris. Animals that did not prove to be hypersensitive toward horse serum yielded a fat layer in the blood, to about the same extent as does cat-blood, but so far the phenomenon to which

we refer is, quantitatively at least, much more marked, and apparently different from the fat phenomenon in cats.

Large quantities of this material seemed distributed thruout the body so that the voluntary muscles of the chest, the surface of the right heart, the large veins up to the lungs, the diaphragm, and especially the upper portion of the alimentary tract, appeared whitish. The large blood vessels of the stomach and upper half of the intestines stood out in striking contrast as a white net-work. The large veins being at the same time greatly distended.

After a lethal dose of horse serum the heart continues to beat some time after cessation of respiratory movements, the ventricles contract with rapidly diminishing force and frequency until finally only occasional twitches are recorded, while the auricles beat quite vigorously for some time later. The heart muscle, however, even after ceasing to beat rhythmically responds to mechanical stimuli for some minutes thereafter.

The respiratory muscles of the chest, the diaphragm, as well as other voluntary muscles respond to mechanical stimuli after stoppage of the heart.

The appearance of the respiratory and circulatory phenomena in the anaphylactic opossum, therefore, lies between those described for the cat and those for the guinea-pig, and death probably ensues from asphyxia and low blood pressure. This low blood pressure being due to a weakening of the heart, increased pulmonary resistance and a consequent engorgement of the right heart and large veins, the primary cause of which is doubtless to be found in the chemical and physical changes in the blood and tissue cells after a toxic dose of serum.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this journal and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

ASTRONOMY.—*Catalogue of 23521 stars between 13° 35′ and 45° 25′ south declination for the equinox 1850. From zone observations made at the United States Naval Observatory 1846–1852.* Compiled by W. S. EICHELBERGER and F. B. LITTELL. Publications of the United States Naval Observatory, Second Series, 7: Pp. XLVII + 558, 4°. 1911.

These observations were made in pursuance of an ambitious plan of the first superintendent of the observatory for "a regular and systematic exploration of the whole heavens from 45° South . . . . . with the intention of penetrating with the telescopes every point of space from that parallel of Declination up to the North Pole, and of assigning position to every star, down to the 10th magnitude." The plan was much too large for execution by the force available at the Observatory within any reasonable time, and after a desultory campaign extending over about six years, it was apparently abandoned. During that time the region of the sky from south declination 45° to south declination 10° was partially covered in an irregular way, some parts being covered repeatedly, some once, and some not at all.

Three instruments were used, the meridian circle, the mural circle adapted for right ascension work as well as its usual declination work, and the transit instrument adapted for declination work in addition to its usual right ascension work. All the work was strictly zone work, the instrument being clamped in a given position and stars being observed as they passed through the field of the telescope.

The journal publication of the bulk of the zones has already been issued. The first publication was issued in 1860 and contained the results of the Meridian Circle Zones observed in 1846, compiled by Assistant Astronomer James Ferguson. The completion of the reductions of the other zones was turned over to Dr. B. A. Gould in 1861, and in

1867 the results were sent to the Observatory ready for printing. In 1872 the Mural Zones were published with an introduction by Prof. Asaph Hall, U.S.N., and later in the same year the Meridian Transit Instrument Zones were similarly published, In 1873 the remaining Meridian Circle Zones were published and in closing the introduction Professor Hall says, "On account of the inexperience of some of the observers and the lack of good organization these observations contain many errors, and the whole work needs a careful revision. In order to facilitate this revision, and the final arrangement of the stars into a catalogue, a list of 415 stars has been selected from the Mural Zones, and these stars will be observed anew with the Pistor and Martins Meridian Circle. With this new data, combined with the results obtained from southern observatories, it is hoped that we may have the means of deriving from these zones a valuable catalogue of southern stars." This particular plan of reducing the zone observations, however, was never executed.

In 1892, as a preliminary step to the formation of a catalogue all the observations were copied on cards under the direction of Prof. J. R. Eastman, U.S.N.

In 1902, a considerable number of unreduced zone observations were found in the files of the observatory. They were reduced under the direction of Prof. F. B. Littell, U.S.N., and they furnish about 6000 of the 44900 observations in this volume. Nearly all of these observations were taken in 1851 and 1852 using the then newly introduced method of the electric chronograph for recording transits. It is interesting to note that the increase of accuracy due to this change was, as is generally conceded to be the case, not great for a transit over a single thread, the results of these observations indicating an advantage of about 6 per cent in accuracy for the chronographic method. However, as five threads could be observed by this method in the time taken to secure two threads by the eye and ear method, and as many of the earlier observations were restricted to but one or two threads on account of lack of time, the real gain from the introduction of the chronographic registration by which five threads were usually secured was much greater. Indeed for this particular work, as it was done, it is likely that the increase of accuracy due to the use of the chronographic method averaged nearly 75 per cent. With the transit instrument in 1851–52, the declinations were obtained by means of chronographic transits over sets of oblique threads inclined at an angle of 45° to the right ascension threads. From a comparison of the results however, no gain was shown by this method

over the more usual one employing a zenith distance micrometer which had been used with this instrument in the earlier observations. These observations have not been published in journal form.

In 1901, the demand for a catalogue of these observations for use in the preparation of the Geschichte des Fixsternhimmels became so insistent that Prof. W. S. Eichelberger, U.S.N., undertook the work of forming the catalogue, with such reduction as might be necessary. The plan adopted was to select a catalogue rich in stars in this region, and using its positions as standards, to reduce these zones to the system of the selected catalogue with the greatest rigor possible. The catalogue selected as the standard was the Cordoba General Catalogue. The work involved was very great, especially as there were an excessive number of blunders of record due to the inexperience of many of the observers. To the painstaking care with which this plan has been carried out must be ascribed the value of the resulting positions.

Without the Cordoba General Catalogue, it would have been impossible to have made a satisfactory discussion of these zones, as no other catalogue would have furnished a sufficient number of reference stars to determine the peculiar errors which affect many of the zones. Furthermore, without the assistance of the Cape Photographic Durchmusterung which was published 1896–97, it would have been impossible to have corrected many of the numerous errors of record of the stars too faint to be in other catalogues. The column of notes bears testimony to the necessity for such a check on the observations. While, therefore, the formation of a catalogue of these observations may be regarded as having been unduly delayed, it is in some respects fortunate that it was not done until these works were available for use in its formation.

The catalogue gives the separate positions resulting from each observation. The probable errors vary considerably for the three instruments, the average being about $\pm 0^s.07$ for a single observed right ascension and $\pm 1''.3$ for a single observed declination. For comparison it may be stated that the corresponding probable errors for the Astronomische Gesellschaft zone observed at this Observatory from 1894 to 1901 were $\pm 0^s.050$ in right ascension and $\pm 0''.53$ in declination. A considerable part of the excess in probable error of the earlier observations is undoubtedly due to the large zenith distance, averaging about 66°, at which the observations were made. All things considered, it appears that the right ascensions determined by the Transit Instrument and the Mural Circle, and the declinations determined by the Mural Circle are fairly satisfactory.

Inasmuch as one important use of this catalogue will be in the statistical study of proper motions, since for many of these stars these are the earliest observations ever made, it was highly desirable to determine corrections which would reduce the system of the catalogue of reference, the Cordoba General Catalogue of 1875, back to 1850 the epoch of this catalogue. This was done by making a comparison between the Cordoba General Catalogue and the Cape Catalogue of 1850, and the systematic corrections resulting from this investigation have been applied so that the positions in this catalogue are virtually those which would have been obtained by the use of a reference catalogue of its own epoch. The system of this catalogue is therefore that of the Cape Catalogue of 1850.

F. B. LITTELL.

NAVIGATION.—*Daylight observations on Venus.* J. P. AULT. Bulletin American Geographic Society. October, 1911.

The writer gives a summary of his experience in making daylight observations on Venus as navigating officer on board the *Carnegie*, the magnetic survey yacht of the Carnegie Institution of Washington, during her first cruise in the North Atlantic, 1909–1910. The usual instruments and methods used in making observations on the Sun were employed in observing on Venus. Tabulations of observations both for latitude and longitude are given. The observations for latitude were usually made by two and sometimes by three observers and the results never differed by more than 0.5 minute of arc and usually agreed within 0.1 minute. The observations for longitude also indicated that uniformly good results can be obtained. The novelty of observing a star by daylight adds enough interest to the work of the navigator to warrant undertaking the operation without any other inducement, but there is added to this at least two opportunities for an accurate determination of the ship's position entirely independent of the operation of dead reckoning.

J. A. FLEMING.

ATMOSPHERIC ELECTRICITY.—*Atmospheric electricity observations on the second cruise of the "Carnegie," from New York to Colombo.* EDWARD KIDSON. To appear in the Journal of Terrestrial Magnetism and Atmospheric Electricity.

This paper gives tabulations together with a synopsis of the observations taken for the specific conductivity of the atmosphere, radioactivity, and potential gradient of the atmosphere, as determined on board the *Carnegie* on her second cruise between New York and Colombo during

June 1910 to June 1911. As a rule the conductivity observations so far obtained by the Department of Terrestrial Magnetism seem to indicate a diminution of the conductivity in equatorial regions and, at any rate during the daytime, in the near neighborhood of land. At the same time the ratio of the conductivity of positive electricity to that for negative becomes smaller. The equatorial regions are perhaps regions of upward currents. Gerdien's apparatus was used for the determination of the specific conductivity of the atmosphere, the aluminum leaf electroscope, however, being replaced by a string electrometer as described by Lutz. The amount of radioactivity obtained varied in very irregular manner, but little activity was shown in midocean. The potential gradient observations indicate a low potential gradient, being associated in general with high conductivity and vice versa. Thus, when the conductivity was very low during a fog the potential gradient was high.

J. A. FLEMING.

PHYSICS.—*The influence of pressure on the melting points of certain metals.* JOHN JOHNSTON and L. H. ADAMS, Geophysical Laboratory. American Journal of Science, (4) **31**: 501. 1911.

The authors have been engaged in developing methods and apparatus by means of which it will be possible to investigate the effects of high temperatures and pressures on certain systems and reactions, and especially those in which water plays an important part. The work has progressed until now we are able to introduce into the bomb current leads and thermo-element wires in such a manner that the wires are all thoroughly insulated electrically, and the joint remains absolutely pressure-tight. Thus, it is possible to heat a substance to somewhat over 400°, under pressures up to 2,000 atmospheres, and to measure both temperature and pressure with precision. Moreover, the whole system, by reason of the special methods of construction adopted, is absolutely free from pressure leaks, even when the bomb is repeatedly closed and opened, disconnected from, and reconnected with, the remainder of the high-pressure system. For instance, on one occasion heating was continued for 30 hours continuously at a pressure of 1800 atmospheres, without sensible loss of pressure in the whole interval.

With this apparatus, the melting-points of tin, bismuth, cadmium, and lead were determined, first at atmospheric pressure, and afterward with a gradual increase of the pressure up to 2,000 atmospheres. The change of melting temperature with pressure was found to be an accurately linear function of the pressure.

By substitution in the Clausius-Clapeyron equation of the data of Vicentini and Omodei on the volume-change at the melting-point, and of Person on the latent heat of fusion, dt/dp was calculated for each of the four metals. The calculated values are in satisfactory agreement with those observed. Incidentally, a convenient standard curve for the calibration of copper constantan thermo-elements at temperatures from 0 to 425° has also been computed and included in the paper.

L. J. and L. H. A.

CHEMISTRY.—*The phenomenon of occlusion in precipitates of barium sulphate and its relation to the exact determination of sulphate.* JOHN JOHNSTON and L. H. ADAMS. Journal American Chemical Society, **33**: 829. 1911.

The occlusion by barium sulphate of other sulphates is a general phenomenon. The amount of this occlusion depends upon (*a*) the composition of the original solution; (*b*) the fineness of the precipitate, which in turn is conditioned by the degree of solubility of barium sulphate in the particular medium, the rate of precipitation, and the time and manner of standing between precipitation and filtration. The phenomenon is therefore in all probability an absorption at the surface of the grains of the precipitate, since it is affected by the factors just mentioned.

On the basis of the knowledge gained in this way, attempts were made to find a direct method for the determination of sulphate which should be generally applicable, exact, and require only small and easily determined corrections. The following procedure is suggested: To the solution (300 cc. for a precipitate to weigh 2 grams) add 50 cc. of concentrated hydrochloric acid, heat to boiling, and precipitate, stirring constantly, with a 10 per cent solution of barium chloride. This should be added at such a rate that about four minutes is required in running in the 22 cc. necessary; the rate is best regulated by attaching a suitable capillary tip to the burette containing the barium chloride solution. Evaporate the whole to dryness on the steam-bath (this may be done immediately after precipitation), take up with hot water, filter thru paper, wash until the washings are free from chloride, ignite very carefully (so as to obviate reduction), and heat to constant weight over a Bunsen burner. The necessary correction is determined by a concurrent calibration of the method; that is, by dissolving an equivalent weighed amount of pure dry sodium (or potassium) sulphate in a medium such that the resulting solution is as nearly as may be of the same composition as the solution to be analyzed; the sulphate in this comparison solution is then

determined precisely as above. The difference between the calculated amount of barium sulphate and that actually found is the correction to be applied to the weight of the precipitate obtained in the actual analysis.

This procedure, as compared with that advocated by Allen and Johnston, is easier and much more rapid; it is, however, not so generally applicable, but may be used whenever the composition of the solution containing the sulphate to be determined is known approximately; and, we believe, will yield results, accurate to ± 0.05 per cent of the total sulphate present, in most cases likely to occur in general analytical work.

J. J. and L. H. A.

GEOCHEMISTRY.—*The data of geochemistry (second edition).* F. W. CLARKE. Bulletin U. S. Geological Survey No. 491. Pp. 782. 1911.

This work was first published in 1908. The present volume has been revised and much enlarged. F. W. C.

PETROLOGY.—*The methods of petrographic-microscopic research: Their accuracy and range of application.* FRED. EUGENE WRIGHT. Publication No. 158, Carnegie Institution of Washington. (In press.)

During the past six years the work with artificial silicate preparations in the Geophysical Laboratory has imposed new and difficult problems to be solved by the microscope. Not only are such preparations very fine-grained, but the degree of accuracy of each measurement must be definitely known if it is to be applied without reserve to geophysical problems. To meet these new conditions, it has been necessary to devise new methods, involving extensive alterations in the microscope, and also to test the different methods available for the determination of the optical constants of minerals in the thin section and to ascertain their relative accuracy and general applicability. As a result of these tests, the methods best adapted for work with artificial and all fine-grained preparations are now fairly well established and their application has become in large measure a matter of routine.

The present publication aims to offer a connected presentation of the entire investigation of the petrographic microscope so far as it has been carried, in which the different methods are coördinated and the significance and usefulness of each particular method is made to appear in its proper relation. An effort has been made to establish the limits of accuracy of each method as ordinarily used, and also the limits of accuracy theoretically attainable in measurements of this kind.

It may be stated, as a result of experience, that on clear individual grains measuring from 0.01 to 0.03 mm. in diameter, all the optic properties ordinarily employed in the petrographic microscopic investigation of minerals in the thin section can now be determined with a satisfactory degree of accuracy.

The introductory chapter contains a statement of the general theory of the microscope and the uses of its individual parts and accessories. Chapter I includes the application of the microscope in the determination of properties of the first class (color, pleochroism, absorption, crystal habit, optical, character, dispersion, etc.), which do not admit of numerical measurement. The properties of the second class which admit of accurate determination and numerical expression are treated in the following chapters: Chapter II, Refractive indices; III, Birefringence; IV, Extinction angles; V, Optic axial angles. F. E. W.

GEOLOGY.—*Geology of the Berners Bay region, Alaska.* ADOLPH KNOPF. Bulletin U. S. Geological Survey No. 446. Pp. 58, with 2 maps. 1911.

Berners Bay is a broad and deep indentation from Lynn Canal, in latitude 58° 42′ north and longitude 135° west. The region under consideration, whose areal extent is 50 square miles, embraces the long, tapering peninsula and its mountainous background that lies between Berners Bay and Lynn Canal, and is at the northwestern extremity of the long zone of auriferous mineralization on the mainland of southeastern Alaska, known as the Juneau gold belt.

The Berners formation of slates and graywackes occupies the larger part of the area and is well exposed on both sides of Berners Bay. The strata show locally intense plication, but as a rule strike northwest and southeast and dip steeply northeast. Fossil plants, consisting chiefly of ferns, are indicative of Jurassic or Lower Cretaceous age. The older view that the rocks of the Juneau gold belt are Carboniferous therefore needs modification; it is probable that the rocks of the productive part of the velt are mainly late Mesozoic.

Northeast of the sedimentary rocks is a belt of much altered lavas, chiefly basaltic amygdaloids. Northeast of these is an intrusive quartz diorite gneiss, which constitutes the crushed and foliated margin of the granitoid core of the Coast Range.

The most important rock in the region from an economic point of view is the Jualin diorite, which invades both the sedimentary and volcanic rocks. The main ore bodies lie within its area. These are auriferous deposits of low grade, most of which are well-defined fissure veins or

irregular stockworks. The veins are up to 15 feet wide, but the average is 5 feet. The stockworks are up to 80 feet wide, averaging from $3 to $5 a ton in gold, and constitute the principal deposits. The gangue material of the ores is quartz with subordinate calcite, and the principal sulphide is pyrite with which are subordinate chalcoyprite, galena, and sphalerite. Free gold is rarely seen.

The wall rock of the ore bodies has been affected by locally intense hydrothermal metamorphism, characterized by the development of albite in small veinlets. This metamorphism is similar to that which has transformed the Treadwell albite-diorite dike into an auriferous lode. The ores are therefore of deep-seated and probably of magmatic origin.

The diorite rocks of the Berners Bay and Juneau regions are part of the great chain of batholithic Mesozoic intrusions that extends from the Sierra Nevada of California northward into Alaska. Here, as in California, the ascent of these magmas was accompanied by metallization of great economic importance. A. K.

GEOLOGY.—*Geology and mineral resources of parts of the Alaska Peninsula.* WALLACE W. ATWOOD. Bulletin U. S. Geological Survey No. 467. Pp. 137, with maps, sections, and views. 1911.

The Aleutian Range forms the axis of the Alaska Peninsula, which is the land mass separating the northern Pacific from Bering Sea. On the Pacific side the mountains lie close to the sea, and the shore line is broken by numerous embayments; on the Bering Sea side they are separated from tidewater by a coastal plain which is notched by several shallow bays and lagoons.

The geologic history of the Alaska Peninsula, so far as it has been determined, is limited to Mesozoic and Cenozoic times. Some granitic rocks in the northwestern portion of the province are known to be of pre-Upper Jurassic age, but no rocks on the peninsula are definitely known to be pre-Triassic. Since the opening of Mesozoic time sedimentation has been going on in some portion of the peninsula during each of the great geologic epochs, with the possible exception of the Pliocene and Oligocene. The Triassic is represented in at least one locality. Large areas of Jurassic sediments represent at least portions of the Middle Jurassic and the Upper Jurassic series. The Lower Cretaceous and the Upper Cretaceous are also present. There are also Eocene, possibly some Oligocene, and certainly some Miocene sediments in the province. From the Eocene epoch to the present time there have been numerous volcanic outbursts at various places on the peninsula, and a portion of the material ejected from the volcanoes is possibly of Pliocene age. The Pleisto-

cene or glacial epoch is represented by morainic deposits and some unconsolidated sands, clays, and gravels. Since the close of Pleistocene time there has been an accumulation of alluvial deposits in the valley bottoms, along the shores and at the heads of the bays.

The structure of the peninsula is that of an anticlinorium. Faulting has occurred as many places. In some faults the movement along a single plane was as much as 1000 feet, and in others systems of distributive faults developed, with movements ranging from a few inches to several rods along the separate fault planes. Much of the lava that rose beneath the peninsula during the periods of volcanism failed to reach the surface. Some of this remained in vertical or nearly vertical fissures as dikes, other masses spread out between sedimentary strata as intrusive sheets or sills, and some entered the sedimentary series as great laccoliths and lifted the overlying beds in large domes.

A. H. BROOKS.

BACTERIOLOGY.—*XIV. The artificial cultivation of the bacillus of leprosy.* DONALD H. CURRIE, MOSES T. CLEGG, and H. T. HOLLMANN, Public Health and Marine Hospital Service. Public Health Bulletin 47.

Lepri bacilli were first cultivated artificially in 1909 by Clegg, who grew them in symbiosis with amoebae and s. cholerae. The authors refer to the bearing of this epoch making discovery on subsequent studies of transmission and serum therapy of leprosy, present a review of the literature on the subject, and record the growth of nine strains of acid fast organisms, six being different strains of leprosy bacilli, one the grass bacillus of Moeller, one the bacillus Margarine, and one the Smegma bacillus. The investigations were made at the U. S. Leprosy Investigation Station, Hawaii. The cultural characteristics of the above mentioned organisms are described, and a summary of the results presented.

No appreciable difference was noted between the individual cultures of the six strains of lepri bacilli worked with. Only slight differences were noted in any of the organisms, and these are not regarded as being of practical importance as a means of differentiation. The serum of a horse that had been immunized to lepri bacilli strongly clumped all of the strains of this organism worked with, but failed entirely to clump the other three organisms. As a result of their work, the authors conclude that by the method of Clegg, it is frequently possible to grow an acid fast bacillus morphologically similar to the leprosy bacillus from the tissues and organs of lepers, and that it is possible to isolate this acid fast organism in pure culture. The acid fast organism thus isolated

resembles culturally other members of this group, but serum tests are capable of differentiating it from the other organisms worked with.

J. W. KERR.

BACTERIOLOGY.—*XVII. Further observations in rat leprosy.* DONALD H. CURRIE, and HARRY T. HOLLMANN, Public Health and Marine Hospital Service, Honolulu, T. H. Public Health Bulletin 50.

The authors refer to a previous article ("A Contribution to the Study of Rat Leprosy," Public Health Bulletin No. 41, Public Health and Marine-Hospital Service of the United States, Washington, D. C., November, 1910) in which they found that a broncho-pneumonia with septicemia, due to the bacillus of rat leprosy, often preceded the better known lesions of the disease. They further observed that a certain mite (Laelaps echidninus) when found on the bodies of infected animals, often contained the bacillus of rat leprosy.

In the present article, they record further observations of a similar character, and close by concluding as follows:

"*First:* In the disease that we are dealing with, whether the animal is inoculated by a laboratory method or simply allowed to develop the disease from coming into contact with infected rats (i.e., the natural mode of infection) the lesions met with are practically the same."

"*Second:* With the exception of the local lesion, occasionally produced at the site of artificial inoculation, infection of the viscera seems to usually precede the lesions of the skin."

"*Third:* Of the visceral lesions, a broncho-pneumonia is often the earliest, and the most constant. Infection of the spleen is also often an early event."

"*Fourth:* The heart blood of infected rats often contains the bacilli of rat leprosy, and no difficulty is experienced in demonstrating the presence of acid-fast bacilli in the mites, contained on the bodies of these animals, when the latter's heart blood contains the organism."

"*Fifth:* The fact that these mites contain the bacilli so frequently naturally leads one to suspect that they may be one of the means of transmitting the disease from rat to rat, but up to the present time we have no positive evidence that such is the case." DONALD H. CURRIE.

EPIDEMIOLOGY.—*The Causation and prevention of typhoid fever, with special reference to conditions observed in Yakima County, Washington.* L. L. LUMSDEN, U. S. Public Health and Marine-Hospital Service. Public Health Bulletin 51.

The bulletin presents (1) a general consideration of the causation and prevention of typhoid fever with particular reference to conditions in

the United States; (2), a detailed discussion of the typhoid fever situation in Yakima County, taken as a somewhat typical instance of high typhoid fever prevalence in American communities; and (3) a report on an investigation of typhoid fever in North Yakima, Washington. Following the body of the report are two appendices. The first (A) being on the subject of the construction and maintenance of a sanitary privy and the second, (B) on the subject of measures to prevent the spread of infection from the bedside of a typhoid fever patient. The bulletin is well illustrated, and is written in semi-popular style so as to be readily intelligible to the lay reader.

The section on typhoid fever in North Yakima deals particularly with an outbreak of the disease in May and June, 1911, which was attributed to infection in water pumped into the city mains from a pond used as an auxiliary source of water for a large lumber mill on the edge of the city, and with a sanitary campaign carried out in the city in the summer of 1911. The author concludes that as a result of the campaign the rate of prevalence of typhoid fever in North Yakima for the summer and fall of 1911 was reduced by over 90 per cent. L. L. L.

PATHOLOGY.—*XVIII. A statistical study of the nasal lesions in leprosy.* HARRY T. HOLLMANN, U. S. Public Health and Marine Hospital Service, Honolulu, T. H. Public Health Bulletin 50.

This article gives the results of the examination of the nasal mucous membrane of 500 lepers, and shows that of these cases, 152 of the nodular type of this disease showed lesions of the nasal mucous membrane, while 19 of the same type showed no nasal lesions. Of the anaesthetic type, 174 presented nasal lesions, while in the case of 53 the nasal mucosa appeared normal. Of the mixed type of the disease, 84 presented nasal lesions, while 18 were free from them.

The nasal lesions mentioned included hypertrophic rhinitis, atrophic rhinitis, perforation of the nasal septum and absorption of cartilage. Of these several types of lesions, the latter was the one most commonly met with. DONALD H. CURRIE.

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PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES, PHILOSOPHICAL, AND BOTANICAL SOCIETIES

A joint meeting of the Philosophical Society with the Washington Academy of Sciences was held October 28, 1911. President Clarke of the Academy introduced Prof. ARTHUR SCHUSTER, who spoke on *The foundations of physics.*

This subject is one that affects the whole of physical science. There is at the present moment a general feeling of unrest which has definitely altered some of our scientific beliefs and shaken our belief in others. The great discoveries of recent years have revolutionized our ideas of matter and force which we had considered settled. We must often accept revolutions when they are accomplished, tho we may not like them, but we may also bear in mind the warning of Kepler, and in the words of a German proverb, be careful when emptying the bath-tub not to turn out the baby with the dirty water.

The science most of us have learned in our youth was based on the laws of motion, established by Galileo, Huygens and Newton. Its fundamental principles were: Constancy of Mass; Action and Reaction, involving Constancy of Momentum; to these was added later Conservation of Energy. The consideration of these together led to the view that they could explain all physical phenomena, giving the materialistic system of which we may take Kelvin as the most typical exponent. The phenomena of light added the ether as a definite substance being able to contain energy and therefore possessing mass. To Kelvin the ether could have no properties not inherent in ordinary matter. The third law of Newton in the past was true affecting matter only, but if necessary ether may contain momentum; this requires a revision of our ideas concerning the laws of motion.

There has always been a concurrent stream of metaphysics as illustrated in some of the writings of Kirchhoff, Hertz, Mach and others. But independently, the idea of the Conservation of Energy introduced quasi-metaphysical ideas such as Potential Energy, Energy Paths, and the Atomic Constitution of Energy. Physical science must get rid of the metaphysics, and a good deal of unnecessary trouble existing in our ideas on physics is due to the tendency to mix physics and metaphysics.

Concerning the question of cause and effect, the doctrine of Kirchhoff that in physical science it is only necessary to describe things as they are and not to explain them, is not sufficient nor is it physics.

The matters thus far spoken of really belong to the old physics. Maxwell's theory of light was the origin of the new. This theory requires the assumption of an ether with properties not hitherto known, an ether that would transmit electrical energy and also transmit light, and which need not have the properties of matter as we know it. When light is transmitted thru ether there is momentum, hence the concept of the pressure of light. The momentum in Maxwell's theory comes out just one-half that in the corpuscular theory of light.

Electricity is probably of an atomic nature, but we need not attach any idea of mass, in the old sense, to the atom of electricity, yet it possess energy and will behave as tho it had mass. Whether or not we may consider the mass of a body to vary with the surrounding energy, it is not legitimate to assume that the mass of an atom is the sum of the component electrons. There are many difficulties in satisfactorily accounting for the relations of mass to gravitation and at the same time reaching a satisfactory electron theory of matter.

The new idea of mass then, places it in the ether and involves the abolition of the constancy of mass: it must change with velocity and the addition theory does not hold. The expression "Ether *and* Matter" should be "Ether *no* Matter." From consideration of the instability of motion we are led also to postulate both a longitudinal and a transverse mass.

The really great revolution of modern physical science is based on a single experiment, that of Michelson and Morley who found the ether apparently had no velocity with respect to the earth's motion. No satisfactory explanation of this fact has been found which will also account for many other well known phenomena. Generalization to the principle of relativity sometimes leads to a denial of the ether, tho space carries energy and momentum. We are again in a quandary when we attempt to surmount the difficulties due to rotation. It is an interesting problem that of creation founded on the theory of relativity the expounders of which appear to postulate that we can never find any relations between ether and matter. Are we, then to reject all questions treating of the structure of the ether? Concerning the structure of matter, are really all intramolecular forces of electrical origin and are they the same for molecular and large distances? Do we know that magnetic fields can be calculated inside molecules in the same way as outside?

In conclusion, we must reject the purely materialistic views of Kelvin and must also resist the meta-mathematician who tempts us with a new apple of knowledge disposing of time as merely a fourth dimension of space and promising to unravel the mystery of creation with a formula.

In the discussion Mr. R. S. Woodward stated that the physics of today is yet untried, and that we must be patient and not be scared out of our ancient learning, and that the foundations of the older physics are yet quite unshaken. We should revise our earlier ideas about mass, but the certainty of the conservation of mass is strong. The law of gravitation is doubtful and the most in proof of it is yet to be done. Physics and mathematics are often not distinguished, physics is not

mathematics. Mathematics is only an instrument. Kelvin appealed to observation, some others used mathematics to reach their conclusions. We should cultivate the principle of relativity, and in doing this it was predicted that our earlier views would prove to be but first approximations. That matter is essentially atomic, and that ether can be placed in the same category, which was also Lord Kelvin's view, is the greatest advance in the last twenty years.

A joint meeting of the Botanical Society and the Washington Academy of Sciences was held on the evening of November 14. Prof. W. JOHANNSEN, of the University of Copenhagen, was introduced by President Clarke and spoke upon *Heterozygosis in pure lines of beans and barley.*

He began by stating that the title of the paper being technical might possibly not be understood by those unfamiliar with the nomenclature applied to cross-breeding in plants and animals. The essential sexual element of an individual is called a gamete. These unite forming zygotes. A zygote is therefore a dual being. When these zygotes are like the parent gamete they are called homozygotes, when different heterozygotes. Heterozygosis may therefore be defined as mixed interbreeding.

Two flowers may look alike but give rise to offspring quite different in appearance. These different forms serve to show the latent characters existing in the parent and inherited from previous ancestors. There appear to be influences at work here which resemble the affinities shown in some chemical compounds.

A pure line is one that produces homozygotes. There are apparently chemical laws at work here but what they are we at present but dimly surmise.

The lecturer illustrated his remarks by reference to diagrams showing the effect of crossing certain strains of beans, barley, snails, etc.

In commenting upon the lecture President CLARKE said that the question of the coloration of flowers was doubtless a chemical phenomenon and that the intimate study of the chemistry of these compounds will probably yield some results. As to how chemical substances or reactions can influence form we are at present almost entirely in the dark.

Mr. McDougal said that the work in a botanist's laboratory was necessarily limited, more definitely than actually occurred in nature as he could perform artificial selections at will. Doubtless mechanical as well as chemical factors are at work to produce the varied forms of offspring. These were the problems which the modern physiologist has to face.

FRANK BAKER, *Secretary.*

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 489th regular meeting was held at the Cosmos Club, December 2, 1911, with President DAVID WHITE in the chair.

Under the head of *Brief notes and exhibition of specimens,* GENERAL WILCOX told of finding many pieces of white quartz in the stomachs of the blue grouse.

BARTON W. EVERMANN reported the arrival in the United States of ten more young fur seals from the Pribilof Islands. Two of them were left with Professor Trevor Kincaid of the University of Washington, at Seattle, two were sent to the New York Aquarium, four to the National Zoölogical Park, while two were retained at the Bureau of Fisheries building. Of ten brought last year, four escaped at Seattle, and the other six died. This leaves the two 2-year-old animals at the Fisheries building as the only specimens of the fur seal that have ever been kept in confinement for over a year. The male on November 20 weighs 64 pounds, the female, 43.

L. O. HOWARD reported that Mr. R. S. WOGLUM of the Bureau of Entomology had just arrived from Asia bringing with him from the Punjab, India, six cases of living parasites of white fly (*Aleyrodes citri*) now so destructive to citrus fruits in Florida. Much is expected as a result of this introduction.

The regular program consisted of three communications:

1. *The hooting of the Blue Grouse.* E. A. PREBLE.

During his stay in Jackson Hole, Wyoming, in the spring and early summer of 1911, the speaker had an opportunity to observe and photograph the blue grouse (*Dendragapus obscurus richardsoni*) in the act of hooting. The birds were quite tame and many characteristic attitudes were shown in the lantern slides presented.

2. *Notes on the fishes of the District of Columbia and vicinity.* ALFRED C. WEED.

The waters of the region were divided into five classes, River, Lowland Streams, Creeks, Upland Brooks, and Pools, and some of the more prominent species in each environment were named with general notes on their habits, especially where these differ markedly from those of most other members of the same group, as in the case of the Catfish, *Schilbeodes insignis*, which lives under stones, etc., in the most rapid waters; and the Darter, *Boleosoma olmstedi*, which is found in all waters from the swiftest and coldest to the most stagnant.

In regard to the more prominent introduced species mention was made of their economic importance and of their relation to other species, both native and introduced. The speaker expressed himself as being firmly of the opinion that the German Carp does not destroy eggs and nests of the Black Bass to any appreciable extent, but that it does furnish an abundant food for this fish which could not be supplied by the native minnows. Several of the small native minnows destroy many more eggs and fry than the Carp.

Brief mention was made of some of the more recently discovered native fishes, with statement of the probable reasons for their having so long remained unnoticed.

The talk was illustrated by lantern slides of fishes and their habitats.

3. *On another supposed fruit-bearing fern-like plant of the American Permian.* DAVID WHITE.

The 490th regular, and 32nd annual meeting was held December 16 1910. The reports of the various officers were received.

The following were elected as officers for 1912: President: E. W. NELSON. Vice-Presidents: J. N. ROSE, W. P. HAY, PAUL BARTSCH, A. D. HOPKINS. Recording Secretary: D. E. LANTZ. Corresponding Secretary: N. HOLLISTER. Treasurer: J. W. GIDLEY.

Members of Council: VERNON BAILEY, A. K. FISHER, A. B. BAKER, HUGH M. SMITH, WM. PALMER.

D. E. LANTZ, *Recording Secretary.*

PROGRAMS AND ANNOUNCEMENTS

PHILOSOPHICAL SOCIETY OF WASHINGTON

704th Meeting, Cosmos Club at 8.15 p. m., February 10. Program: FRANK WENNER: *Constancy of wire resistance standards.* ARTHUR W. GRAY: *Measurement of inaccessible displacements, production of temperature uniformity, and determination of expansion of gas-thermometer bulbs.* (Illustrated).